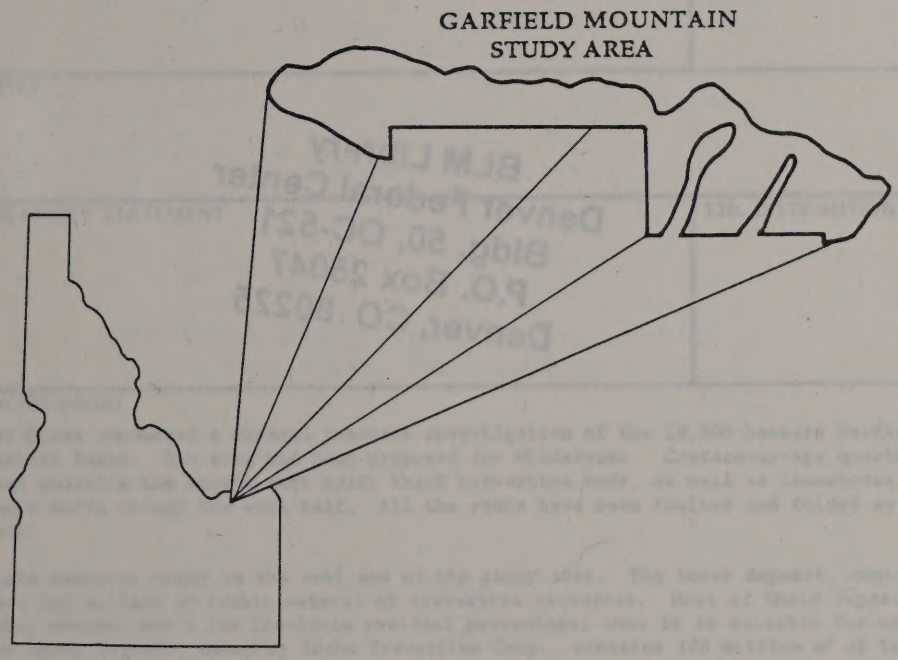
BLM LIBRARY
88077412

MLA 1-93

Mineral Land Assessment/1993
Open-File Report

Mineral Resource Investigation of the Garfield Mountain Study Area, Clark County, Idaho



BUREAU OF MINES

UNITED STATES DEPARTMENT OF THE INTERIOR

TN
23
.M11
no.
93-01

BLM Library
Denver Federal Center
Bldg. 50, OC-521
P.O. Box 25047
Denver, CO 80225

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.

1. AGENCY USE ONLY (*leave blank*)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED

4. TITLE AND SUBTITLE
Mineral Resource Investigation of the Garfield Mountain Study Area, Clark County, Idaho

5. FUNDING NUMBERS

6. AUTHOR(S)

Frank E. Federspiel and Richard L. Rains

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

U.S. Bureau of Mines
Western Field Operations Center
E. 360 Third Avenue
Spokane, WA 99202

8. PERFORMING ORGANIZATION REPORT NUMBER

MLA 1-93

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT

12b. DISTRIBUTION CODE

13. ABSTRACT (*Maximum 200 words*)

In 1992, the Bureau of Mines conducted a mineral resource investigation of the 19,200-hectare Garfield Mountain study area in east central Idaho. The area had been proposed for Wilderness. Cretaceous-age quartzite and limestone conglomerates underlie the area's east half; thick travertine beds, as well as limestones, dolomites, sandstones, and volcanic tuffs occupy the west half. All the rocks have been faulted and folded as part of the Western Overthrust Belt.

Two, enormous travertine deposits occur in the west end of the study area. The lower deposit, controlled by Faxe Kalk Inc., has at least 200 million m^3 (cubic meters) of travertine resources. Most of their deposit is very bright with a high $CaCO_3$ content and a low insoluble residual percentage; thus it is suitable for use as a paper and paint filler. The upper deposit, owned by Idaho Travertine Corp., contains 100 million m^3 of travertine resources; it is used for facing or dimension stone. Weathered travertine outcrops are buff to tan and locally vuggy. Bureau of Mines samples of outcrops contained greater than 95% $CaCO_3$.

Approximately 600 m^3 of travertine have been quarried from the two deposits and used for facing stone. Four travertine quarries and two dozer cuts were examined. Faxe Kalk has 103 White Rock placer claims on the lower deposit; approximately one-half of the claims are within the study area. Idaho Travertine has the Limestone 1 and 2 placer claims on the upper deposit.

A 4,647-m-deep oil and gas exploratory well was drilled on the east end of the study area without success.

14. SUBJECT TERMS

Mineral resources; mineral investigation; Garfield Mountain; Beaverhead Mountains; Dubois, Idaho; Lidy Hot Springs; Bannack Pass; Monda Pass; Medicine Lodge Creek; Fritz Creek; travertine; building stone; limestone

15. NUMBER OF PAGES
17

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT

#27857376
ID: 88077412
TN
23
.M11
no.
93-01

MINERAL RESOURCE INVESTIGATION OF THE GARFIELD MOUNTAIN STUDY AREA, CLARK COUNTY, IDAHO

By
Frank E. Federspiel and Richard L. Rains

Western Field Operations Center
Spokane, Washington

MLA 1-93

UNITED STATES DEPARTMENT OF INTERIOR
Bruce Babbitt, Secretary

BUREAU OF MINES
Herman Enzer, Acting Director

PREFACE

The Wilderness Act (Public Law 88-577, September 3, 1964) and related acts require the U.S. Bureau of Mines and U.S. Geological Survey to survey certain areas of Federal land ". . . to determine the mineral values, if any, that may be present . . ." Results must be made available to the public and be submitted to the President and the Congress. This report presents the results of a Bureau of Mines mineral investigation of the Garfield Mountain study area, Clark County, Idaho, which includes most of the lands in Non-Wilderness Recommended Area No. 4-961 as classified during the Second Roadless Area Review and Evaluation (RARE II) by the Forest Service, January 1979. Subsequent legislative proposals have recommended portions of the study area be classified as Wilderness. Presently, the area is not under Wilderness or Special Management consideration. Mining-related activities in the study area would be severely restricted under any of these designations.

This open-file report contains data gathered and interpreted by personnel of the U.S. Bureau of Mines, Western Field Operations Center, Branch of Resource Evaluation, East 360 Third Avenue, Spokane, Washington 99202. This report has been approved by the Branch of Mineral Land Assessment, Washington, D.C.

Page

SUMMARY 1

INTRODUCTION 2

Setting 2
Previous studies 2
Present study 4

ACKNOWLEDGEMENTS 4

GEOLOGIC SETTING 5

APPRAISAL OF MINERAL RESOURCES 9

Travertine 9
Oil and gas 11

CONCLUSIONS 11

REFERENCES 14

APPENDIX A--Descriptions and analyses of rock samples from the Garfield Mountain study area, Clark County, Idaho 16

APPENDIX B--Descriptions and whole-rock analyses of samples from the Garfield Mountain study area, Clark County, Idaho 17

ILLUSTRATIONS

		Page
Figure 1.	Location of the Garfield Mountain study area, Clark County, Idaho	3
Figure 2.	Mines, claims, and sample localities in and near the Garfield Mountain study area	6
Figure 3.	Geologic map of the Garfield Mountain study area	7
Figure 4.	Photograph of The Thumb along continental divide, underlain by quartzite conglomerate	8
Figure 5.	Photograph of upper part of Fritz Creek travertine quarry	10
Figure 6.	Photograph of quarried travertine blocks	10
Figure 7.	Photograph of quarried travertine blocks at Idaho Travertine Corporation's deposit	12
Figure 8.	Photograph of east end of Idaho Travertine Corporation's deposit	12

UNIT OF MEASURE ABBREVIATIONS USED IN THIS REPORT

centimeter	cm
cubic meter	m^3
degree	°
hectare	ha
kilometer	km
meter	m
part per billion	ppb
part per million	ppm
percent	%

SUMMARY

In 1992, the USBM (U.S. Bureau of Mines) examined the 19,200-ha Garfield Mountain study area to evaluate its mineral resources. The area includes the Non-Wilderness Recommended RARE II Area No. 4-961. The study area is in Clark County, Idaho, about 110 km by air north of Idaho Falls and 30 km by air west of Dubois.

Travertine has been quarried for dimension stone from two, enormous deposits on the west end of the study area. The Gem State Stone Company, now Idaho Travertine Corporation, produced approximately 600 m^3 of travertine intermittently from 1968 to 1976 from quarries near Bannack Pass and along Fritz Creek. The company now owns one of the deposits. More than 20 mined blocks up to 2.4 m, by 1.8 m, by 4 m remain at these quarries.

The lower deposit, extending from south of Fritz Creek northerly up Warm Creek, is held by Faxe Kalk Incorporated of Atlanta, Georgia. The company has 103 White Rock placer claims on the deposit; about one-half of the claims are within the southwest part of the study area. The company estimates a resource of at least 200 million m^3 of travertine are within the study area. Travertine on the claims has historically been mined for dimension stone and as an animal-feed neutralizer by Idaho Travertine and E.J. Wilson and Sons, respectively. However, because Faxe Kalk data show that the deposit has a high brightness (plus 91% on R457 tests), a low insoluble residual percentage (less than 1%), and a high $CaCO_3$ (calcium carbonate) content (plus 99% $CaCO_3$), the material is of excellent quality for use as a paper and paint filler. Other companies are considering the travertine for filler in plastics and for pharmaceuticals. USBM samples of travertine, from weathered outcrops, contained greater than 95% $CaCO_3$. Company drill data show a higher $CaCO_3$ content.

The upper deposit is along the continental divide, on the Limestone 1 and 2 placer claims owned by Idaho Travertine Corporation. This deposit contains over 100 million m^3 of resources of travertine and has been quarried for dimension stone; its intended future use is the same. USBM samples of weathered outcrops of the deposit contained more than 95% $CaCO_3$.

Rocks in the study area have been faulted and folded as part of the Western Overthrust Belt which has historically been an exploration target for oil and gas. Carbonaceous rocks, mainly coal, but no oil or gas shows, were intersected in a 4,647-m-deep hole drilled in the east corner of the area by Shell Oil Company in 1985 and 1986.

INTRODUCTION

This report describes the USBM study to evaluate mineral resources of the Garfield Mountain study area. USBM personnel examined individual mines, claims, prospects, and mineralized zones, and evaluated identified mineral resources. Results of these investigations will be used to help determine the suitability of this study area for inclusion into the National Wilderness Preservation System. Although the immediate goal of this and other USBM mineral surveys is to provide data for the President, Congress, government agencies, and the Public for land-use decisions, the long-term objective is to ensure the Nation has an adequate and dependable supply of minerals at a reasonable economic and environmental cost.

Setting

The Garfield Mountain study area encompasses 19,200 ha of lands administered by Targhee National Forest. The area, along the continental divide, is situated in east central Idaho, about 110 km by air north of Idaho Falls and 30 km by air west of Dubois (fig. 1). Access to study area borders is by graveled and maintained dirt roads from Idaho State Highway 22. Pack trails follow major drainages and most ridges in the area. Snowfall can restrict area travel from November to May.

Study area elevations range from 3,116 m on Red Conglomerate Peaks, along the north central side of the area, to less than 2,220 m near its southeast corner. Garfield Mountain (3,332 m) is in Montana. Area topography is steep, with local relief commonly over 1,200 m per km. Higher elevations support little vegetation besides sagebrush, whereas lower elevations have stands of fir, pine, and some cottonwood and aspen. Winters are harsh with snow packs usually more than 5 m thick; summers are warm and dry, with minimal rainfall.

Previous Studies

The first recorded geological observations in the region were by members of the Hayden Survey in 1872 (Hayden, 1872). Geologic studies, which include all or parts of the area, were by Kirkham (1927), Scholten and others (1955), Scholten and Ramspott (1968), Beutner (1977), Ruppel (1978), Skipp and others (1979), Skipp (1984, and 1985), Rember and Bennett (1979), and Haley (1986). Mitchell and others (1981) plotted and listed mines and prospects in the Dubois Quadrangle. Mineral resource potential of the area was described by Bennett and others (1978), and by Nevins and Oakman (1988). Oil and gas potential were assessed by

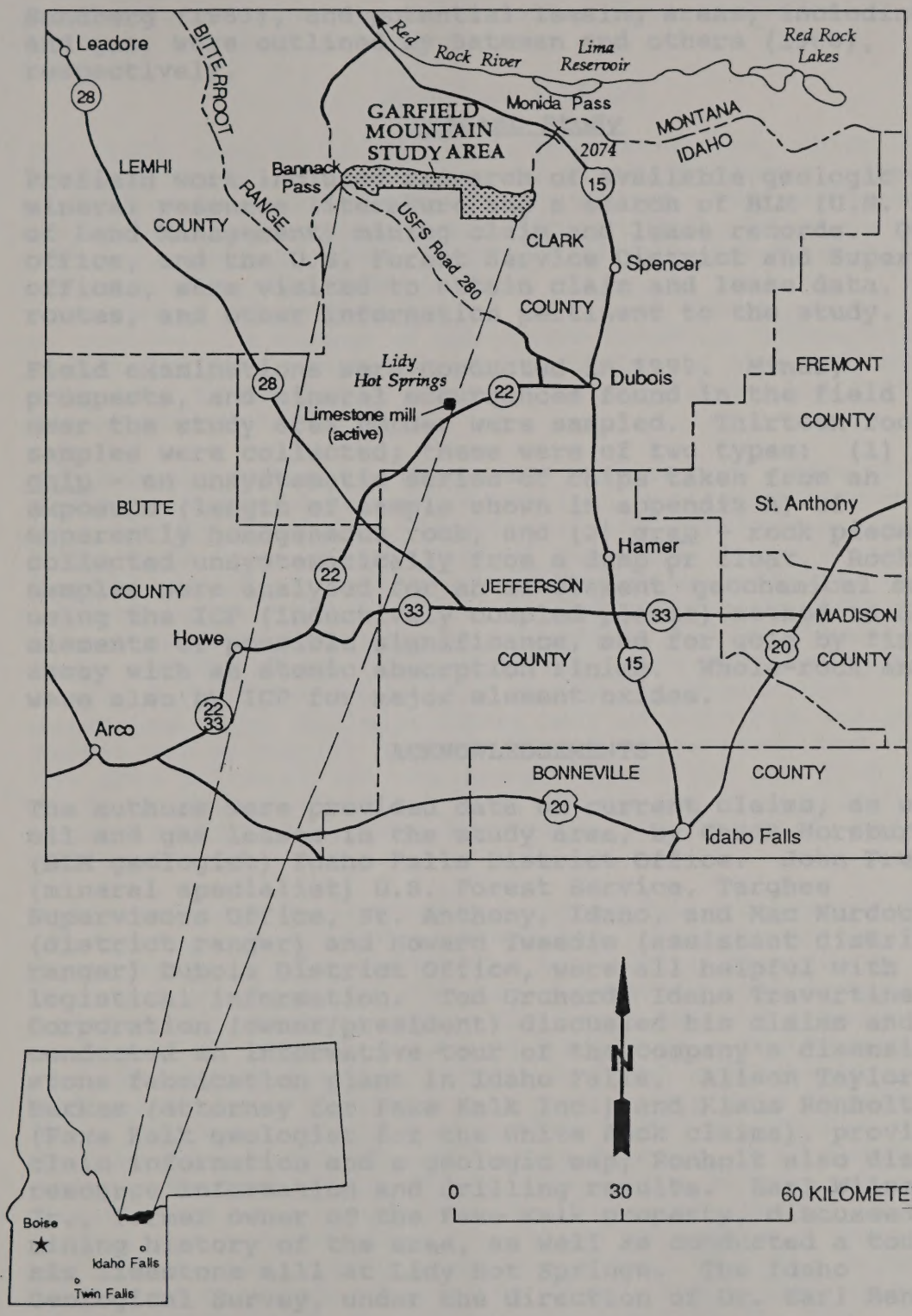


Figure 1.- Location of the Garfield Mountain study area, Clark County, Idaho

Sandberg (1983), and potential leasing areas, including oil and gas, were outlined by Bateman and others (1980), respectively.

Present Study

Prefield work included research of available geologic and mineral resource literature and a search of BLM (U.S. Bureau of Land Management) mining claim and lease records. One BLM office, and the U.S. Forest Service District and Supervisors offices, were visited to obtain claim and lease data, access routes, and other information pertinent to the study.

Field examinations were conducted in 1992. Mines, prospects, and mineral occurrences found in the field in or near the study area border were sampled. Thirteen rock samples were collected; these were of two types: (1) random chip - an unsystematic series of chips taken from an exposure (length of sample shown in appendix A) of apparently homogeneous rock, and (2) grab - rock pieces collected unsystematically from a dump or float. Rock samples were analyzed for an 11-element[1] geochemical suite using the ICP (inductively coupled plasma) method to detect elements of possible significance, and for gold by fire assay with an atomic absorption finish. Whole-rock analyses were also by ICP for major element oxides.

ACKNOWLEDGEMENTS

The authors were provided data on current claims, as well as oil and gas leases in the study area, by Chuck Horsburgh (BLM geologist) Idaho Falls District Office. John Pruess (mineral specialist) U.S. Forest Service, Targhee Supervisors Office, St. Anthony, Idaho, and Mac Murdock (district ranger) and Howard Tweedie (assistant district ranger) Dubois District Office, were all helpful with logistical information. Ted Orchard, Idaho Travertine Corporation (owner/president) discussed his claims and conducted an informative tour of the company's dimension stone fabrication plant in Idaho Falls. Alison Taylor Berkes (attorney for Faxe Kalk Inc.) and Klaus Ronholt (Faxe Kalk geologist for the White Rock claims), provided claim information and a geologic map; Ronholt also discussed resource information and drilling results. Earl Wilson, Jr., former owner of the Faxe Kalk property, discussed the mining history of the area, as well as conducted a tour of his limestone mill at Lidy Hot Springs. The Idaho Geological Survey, under the direction of Dr. Earl Bennett,

---

[1]Antimony, arsenic, bismuth, copper, lead, mercury, manganese, molybdenum, silver, tungsten, zinc

provided geologic maps and minerals data specifically on the Garfield Mountain study area.

GEOLOGIC SETTING

The study area is in the Beaverhead Mountains, which lie between the Lemhi and Centennial Mountain Ranges. Area structure is dominated by thrust faults. The northern extension of the Idaho-Wyoming Thrust Belt, which is a portion of the 3,500-km-long Western Overthrust Belt, has placed older rocks over younger units, as well as contributed to the folding of many beds (Maley, 1987, p. 96-100). A series of northwest-trending, subparallel thrust faults in or along the west side of the area are, from east to west, the Medicine Lodge, Cabin, and Fritz Creek (Skipp, 1985).

The area is underlain, from east to west, by rocks of the Cretaceous-age Beaverhead Formation, Mississippian-age Scott Peak and Middle Canyon Formations, and Tertiary-age Medicine Lodge beds (fig. 3) and Tuff of Blacktail Butte (Rember and Bennett, 1979). The Beaverhead Formation underlies the eastern half of the area and is predominantly quartzite and limestone conglomerates, as exposed at Red Conglomerate Peaks and The Thumb (fig. 4). The Scott Peak and Middle Canyon Formations are mainly cherty limestones and dolomites. The Medicine Lodge beds of Scholten and Ramspott (1968) are primarily travertine and limestones, and contain the area's identified resources. Rhyolitic ash flow tuffs (Tuff of Blacktail Butte) crop out on the west side of the area. Prominent bedding strikes N. 45° to 60° W. and dips 30° to 50° SW.

Medicine Lodge travertine beds were likely deposited from hot springs associated with volcanic activity on the Snake River Plain to the south. Two travertine deposits in the west end of the study area are extensive; both have been mined for dimension stone. The lower deposit (fig. 2, sample localities 1, 2, and 4) is likely a downdropped block from the upper deposit. The beds trend north-northwest and dip gently, mainly to the southwest, away from "mounds". These "mounds", identified by Faxe Kalk, are feeder vents for the travertine deposit (Klaus Ronholt, oral commun., 1992). He also reported that travertine is generally massive and very bright near the "mounds", and it is more porous and vuggy farther from these structures. Company drill data and surface mapping indicate that the deposit ranges in thickness from 40 to 70 m. Where last excavated, in the Fritz Creek quarry (sample locality 5), the travertine has little iron oxide stain and is extremely bright white.

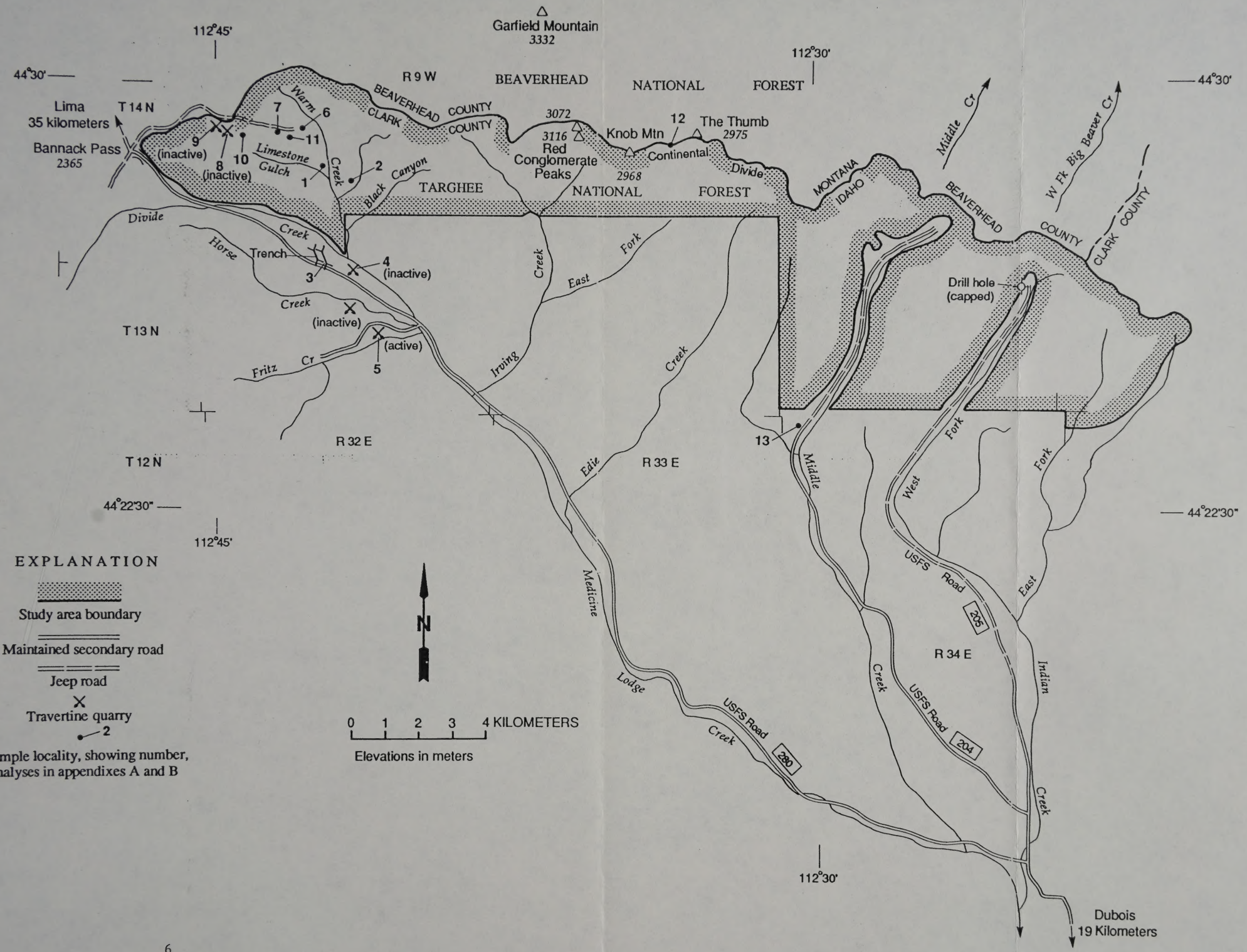
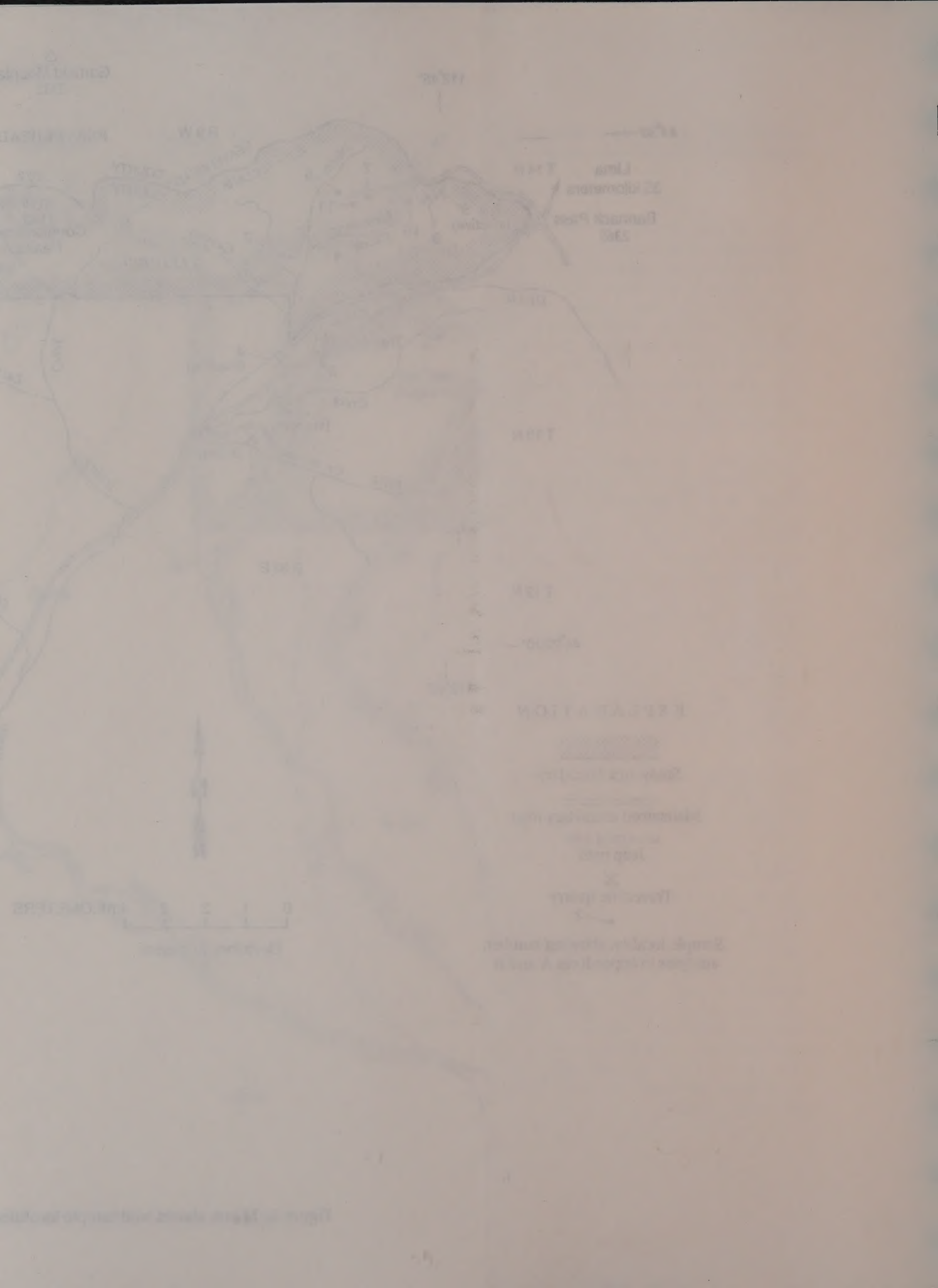
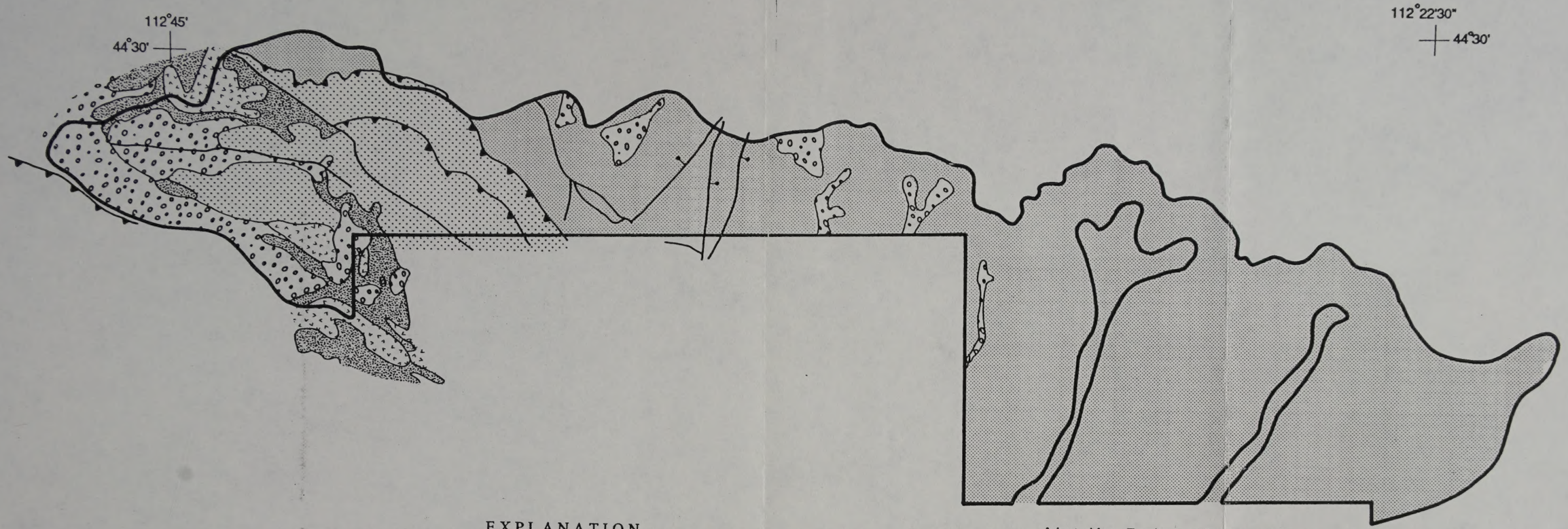


Figure 2.- Mines, claims, and sample localities in and near the Garfield Mountain study area





EXPLANATION

- Study area boundary
- Quaternary-age alluvium, colluvium, and landslide material
- Tertiary-age volcanic rocks, mainly rhyolite ash flow tuffs; Tuff of Blacktail Butte
- Tertiary-age Medicine Lodge travertine and limestone beds
- Cretaceous-age quartzite and limestone conglomerates; Beaverhead Formation
- Mississippian-age limestones, dolomites, sandstones, siltstones, and shales; Scott Peak and Middle Canyon Formations
- Contact
- Fault, ball on down dropped block
- Thrust fault, sawteeth on upper plate

Adapted from Rember and Bennett, 1979, and Scholten, Keeman, and Kupsch, 1955

Figure 3.- Geologic map of the Garfield Mountain study area

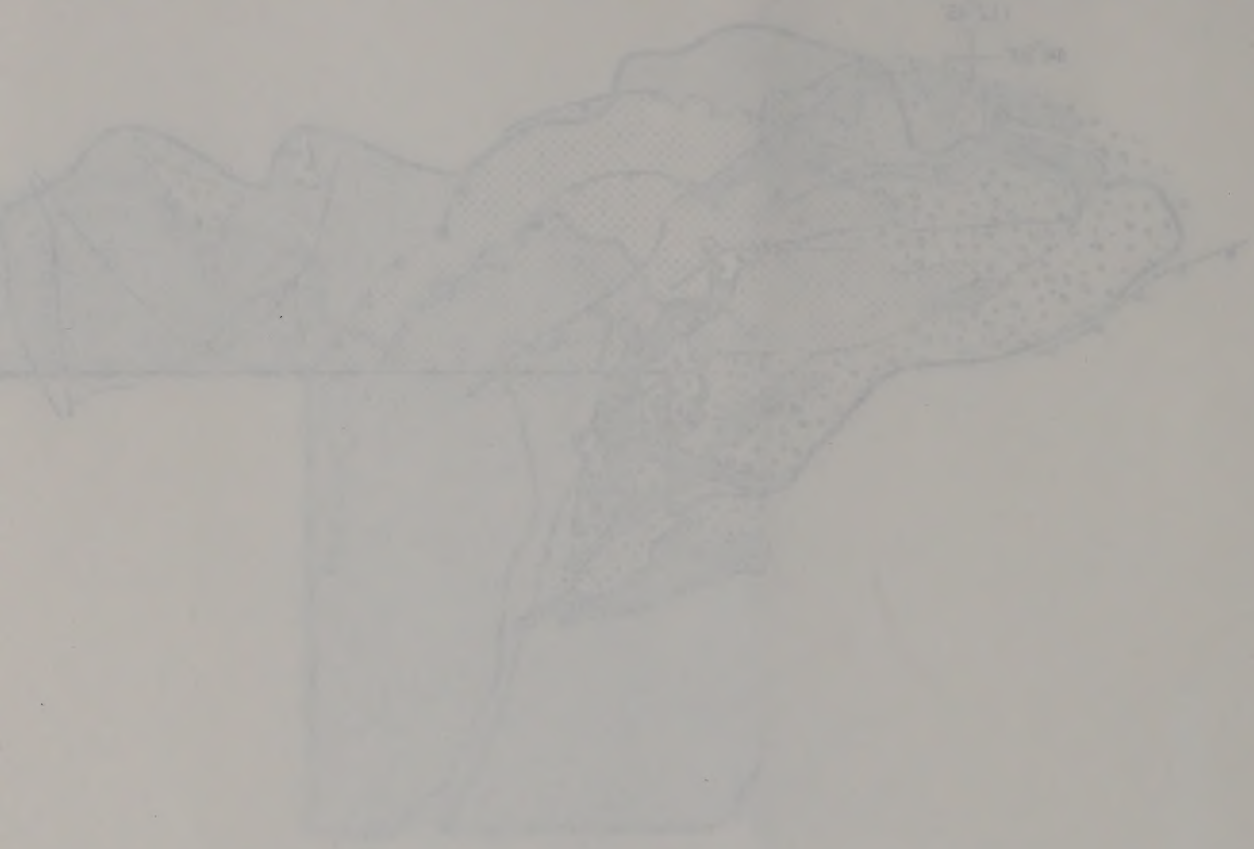


Figure 4.-View of The Thumb (2,975 m) along the continental divide on the north central area border, looking northeast. This part of the area is largely underlain by quartzite conglomerate of the Beaverhead Formation.

The upper deposit (fig. 2, sample localities 6-11) is prominently exposed in cliff faces and along the continental divide for approximately 2.4 km (fig. 3); it is at least 60 m thick. Exposed beds strike N. 85° E., dip 5° to 10° NW., and range in thickness from several cm to more than one meter. Vugs in the beds are commonly less than 1.3 cm in diameter or, if lenticular, 1.3 cm thick and less than 0.3 m long. Laminae from 0.25 cm to 1.3 cm thick are occasionally found between beds; the travertine sometimes breaks along these structures. Minor amounts of silica and iron oxide stain occur on weathered surfaces.

Faulted and folded rocks, ranging in age from Mississippian to Tertiary, were intersected in a 4,647-m-deep hole drilled on the east side of the study area. Some of these formations, such as the Frontier, Nugget, and Quadrant have produced oil and gas in the western states.

APPRAISAL OF MINERAL RESOURCES

The study area contains two closely spaced travertine properties with separate owners. Also, the area has been a target for oil and gas resources. Each travertine property is discussed below. Sample descriptions and analyses are given in appendixes A and B.

Travertine

Travertine has been quarried for dimension stone at various sites in each deposit. Material from the lower deposit is of acceptable quality for paper and paint filler; other uses may include filler in plastics, and pharmaceuticals, as well as an animal-feed neutralizer.

The lower deposit (fig. 2, sample localities 1, 2, 3, and 5) is covered by the 103 White Rock placer claims, nos. 1-153, not inclusive, which are held by Faxe Kalk Inc., headquartered in Atlanta, Georgia. The company obtained many of these claims from Mr. Earl Wilson, Jr., in 1988; he had earlier acquired some of these from Idaho Travertine. The 3.3- to 64.8-ha White Rock placer claims lie south of the Fritz Creek quarry and extend northward to the headwaters of Warm Creek (fig. 2); 46% of the claims are within the study area (A. Taylor Berkes, written commun., 1992). Material from the Fritz Creek quarry (fig. 2, sample locality 5, and fig. 5) and the quarry at sample locality 4 (fig. 6) was mined by Idaho Travertine in the early 1970's. Currently, travertine from the Fritz Creek quarry is being tested for use as a filler in plastics.

According to Klaus Ronholt, the deposit contains over 200 million m^3 of travertine resources within the study area

Figure 5.-View of top of Fritz Creek travertine quarry, looking southerly. Drilled portions of the deposit contain very high $CaCO_3$ (plus 96%) and high brightness (plus 91% by R457 testing). Sample 5 from the quarry had some silica and iron oxide stains, typical of weathered portions of the deposit.

Figure 6.-View of quarried travertine blocks at sample locality 4, formerly the Marble Shop No. 3 claim, but now in the White Rock claim group. These blocks contain larger vugs and thicker laminae than was observed elsewhere in the area.

(oral commun., 1992). Four travertine samples (fig. 2, and appendix B, nos. 1, 2, 4, and 5) taken by the USBM contained 53.40% to 56.05% CaO or approximately 95% to more than 99% $CaCO_3$. Company drill data, discussed with Mr. Ronholt, indicates that $CaCO_3$ content is higher near the "mounds" and, generally, at depth. Drilling results also show that most of the travertine has a high brightness of plus 91% using the R457 standard, and a low insoluble residual percentage of less than 1%.

The upper travertine deposit is in the west corner of the study area. BLM records show that the Limestone 1 and 2 are 64.8-ha association placer claims located by Ted and Joyce Orchard. Approximately 600 m^3 of travertine were quarried from the upper and lower deposits intermittently between 1968 and 1976 (Ted Orchard, oral commun., 1992). Quarried blocks were trucked to Idaho Travertine's fabricating plant in Idaho Falls where blocks were cut and polished mainly for facing stone on office buildings in Idaho Falls and in Odgen, Utah.

The upper deposit contains approximately 100 million m^3 of travertine resources. This estimate is based on a traceable strike length of 2.4 km, a width of 0.8 km in a northwest-southeast direction, and a thickness of 60 m. Much of the southern part of the deposit is exposed in cliff faces, and is readily available for quarrying (figs. 7 and 8). Five samples (fig. 2 and appendix B, nos. 6-10) taken from various localities of the deposit contained from 53.60% to 55.25% CaO or approximately 95% to more than 98% $CaCO_3$, and about 1% SiO_2.

Oil and Gas

The study area lies within the Western Overthrust Belt which contains folded and faulted sediments that have produced oil and gas in neighboring states. Shell Oil Company drilled a 4,647-m-deep hole near the headwaters of West Fork Indian Creek (sec. 24, T. 13 N., R. 34 E.), on the east side of the study area (fig. 2). The hole intersected the Quadrant, Nugget, and Frontier Formations which are source rocks for hydrocarbons elsewhere in the western states. However, drill logs indicate that only traces, to abundant amounts of coal, were intersected. The hole, started in 1985, was plugged and abandoned in 1986. No oil and gas leases are held in the study area.

CONCLUSIONS

Both travertine deposits are of enormous size and of high quality. Although other deposits are in and near the study area, these two deposits will meet anticipated demands. The deposits have been historically quarried for dimension

Figure 7.-View of Idaho Travertine's eastern quarry on the Limestone claims, looking easterly. Material breaks easily into blocks. The continental divide is in the background; Garfield Mountain is in the upper left corner of the photo. USBM geologist is preparing to take sample no. 8.

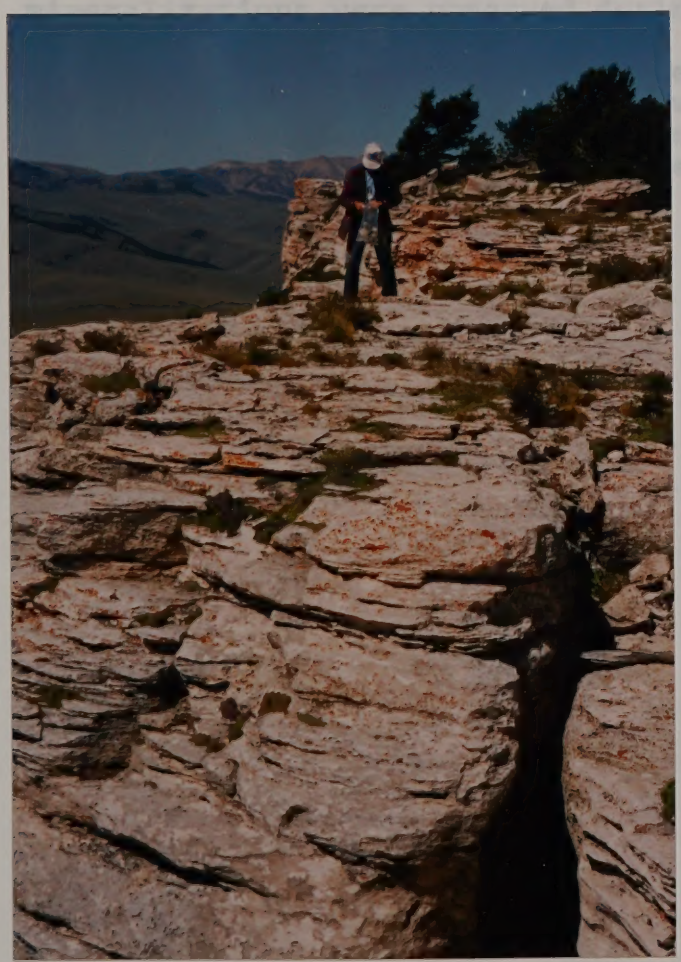


Figure 8.-View of east end of Idaho Travertine's deposit, looking southeast. Travertine beds dip slightly to the northwest. Overburden is minimal. USBM geologist/co-author is collecting sample no 6.

stone. As a large portion of Faxe Kalk's travertine has high brightness, high $CaCO_3$ content, and minimal residual insolubles, the deposit is ideal for filler in paper and paint. When a market is developed, this material will very likely be used.

Idaho Travertine's study area deposit is slightly darker than its travertine deposit along Fall Creek, southeast of Idaho Falls, which is considerably closer to their Idaho Falls fabrication plant. Presently, the slightly lighter-colored material at Fall Creek is preferred by company customers. However, if customer preferences change to the slightly darker travertine, the study area deposit will be mined.

Earl Wilson, Jr., has sold finely ground (100 to 325 mesh) travertine from the Faxe Kalk deposit for use as an animal-feed neutralizer. If this market expands, more travertine will be mined. Other potential markets for the study area travertine include the plastics, pharmaceuticals, and beet-sugar processing industries.

All samples were routinely analyzed for precious and base metals (appendix A). No anomalous concentrations were found; and no significant indications of any other mineralizations were observed during this study.

Oil and gas resources were not investigated by the USBM. Sandberg (1983, p. F5) places a low potential for oil and gas in the study area, based on geology and structure. A 4,647-m-deep drill hole did intersect coal seams; however, no oil or gas was found.

REFERENCES

Bateman, A.F., Jr., Allen, E.G., Bugwyler, J.B., Jr., and Colbert, J.L., 1980, Leasable mineral and waterpower land classification map of the Dubois Quadrangle, Idaho, Montana: U.S. Geological Survey Open-File Report 80-483, 1 sheet, scale 1:250,000.

Bennett, E.H., Gaston, M.P., and Smith H.T., 1978, The mineral potential of lands proposed for wilderness classification in Idaho with emphasis on the RARE II roadless areas: Idaho Geological Survey Technical Report 78-2, 32 p.

Beutner, E.C., 1977, Causes and consequences of curvature in the Sevier orogenic belt, Utah and Montana: in Heisey, E.L., Lawson, D.E., Norwood, E.R., Wach, P.H., and Hale, L.A. editors, Rocky Mountain Thrust Belt, Geology and Resources: Wyoming Geological Association 29th Annual Field Conference, p. 353-365.

Haley, J.C., 1986, Upper Cretaceous (Beaverhead) synorogenic sediments of the Montana-Idaho thrust belt and adjacent foreland: relationships between sedimentation and tectonism: Baltimore, Johns Hopkins University, Ph.D. dissertation, 542 p.

Hayden, F.V., 1872, Preliminary report of the United States Geological Survey of Montana and portions of adjacent territories, being a fifth annual report of progress: Washington, D.C., 538 p.

Kirkham, V.R.D., 1927, A geologic reconnaissance of Clark and Jefferson and parts of Butte, Custer, Fremont, Lemhi, and Madison Counties, Idaho: Idaho Bureau of Mines and Geology Pamphlet 19, 47 p.

Maley, T.S., 1987, Exploring Idaho geology: Boise, Idaho, Mineral Land Publication, 232 p.

Mitchell, V.E., Strowd, W.B., Hustedde, G.S., Bennett, E.H., 1981, Mines and prospects of the Dubois Quadrangle, Idaho: Idaho Bureau of Mines and Geology, Mines and Prospect Series, 22 p.

Nevins, B.B., and Oakman, M.R., 1988, Mineral resource potential of National Forest RARE II and Wilderness areas in Idaho: U.S. Geological Survey Open-File Report 88-0207, 116 p., and plate, scale: 1:500,000.

Rember, W.C., and Bennett, E.H., 1979, Geologic map of the Dubois Quadrangle, Idaho: Idaho Bureau of Mines and Geology, Geologic Map Series.

Ruppel, E.T., 1978, Medicine Lodge thrust system, east-central Idaho and southwest Montana: U.S. Geological Survey Professional Paper 1031, 23 p.

Sandberg, C.A., 1983, Petroleum potential of wilderness lands in Idaho, in Miller, B.M. ed., Petroleum potential of wilderness lands in the western United States: U.S. Geological Survey Circular 902-F, 6 p.

Scholten, Robert, Keenmon, K.A., and Kupsch, W.O. 1955, Geology of the Lima region, southwestern Montana and adjacent Idaho: Geological Society of America Bulletin, v. 66, p. 345-404.

Scholten, Robert, and Ramspott, L.D., 1968, Tectonic mechanisms indicated by structural framework of central Beaverhead Range, Idaho-Montana: Geological Society of America Special Paper 104, 71 p.

Skipp, Betty, 1984, Geologic map and cross section of the Italian Peak and Italian Peak Middle Roadless Areas, Beaverhead County, Montana, and Clark and Lemhi Counties, Idaho: U.S. Geological Survey Miscellaneous Field Studies Map MF-1601-B, scale 1:62,500.

Skipp, Betty, 1985, Contraction and extension faults in the southern Beaverhead Mountains, Idaho and Montana: U.S. Geological Survey Open-File Report 85-545, 170 p.

Skipp, Betty, Prostka, H.J., and Schleicher, D.L., 1979, Preliminary geologic map of the Edie Ranch Quadrangle, Clark County, Idaho, and Beaverhead County, Montana: U.S. Geological Survey Open-File Report 79-845, 1 sheet, scale 1:62,500.

Appendix A.--Descriptions and analyses of rock samples from the Garfield Mountain study area, Clark County, Idaho

[Au, gold; Ag, silver; As arsenic; Bi, bismuth; Cu, copper; Hg, mercury; Mn, manganese; Mo, molybdenum; Pb, lead; Sb, antimony; W, tungsten; Zn, zinc
NA, not applicable; <, less than]

Sample no. (fig. 2)	Sample type	Length (m)	Description	Au (ppb)	Ag (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	As (ppm)	Sb (ppm)	W (ppm)	Mn (ppm)	Bi (ppm)	Mo (ppm)	Hg (ppb)
1	Random chip	10.0	Across tan, slightly iron-oxide-stained travertine outcrop	<5	0.3	20	<2	73	<5	<5	<10	60	<5	1	625
2	Do..	10.0	Do..	7	<.2	15	<2	15	<5	<5	<10	44	<5	1	30
3	Grab	NA	Volcanic tuff and limestone on dumps of dozer cuts	8	<.2	7	5	36	<5	<5	<10	90	<5	2	275
4	Do..	NA	Vuggy, tan travertine with 0.6-cm-thick laminae	7	<.2	10	<2	11	<5	<5	<10	36	<5	1	90
5	Do..	NA	White, crystalline travertine from Fritz Creek quarry	<5	<.2	7	<2	7	<5	<5	<10	25	<5	1	40
6	Do..	NA	Travertine with narrow vugs and laminae	5	<.2	10	<2	19	<5	<5	<10	68	<5	<1	125
7	Do..	NA	Do..	<5	<.2	9	<2	12	<5	<5	<10	80	<5	1	30
8	Do..	NA	Massive, white travertine from eastern quarry on the Limestone claims	<5	<.2	9	<2	7	<5	<5	<10	52	<5	<1	35
9	Do..	NA	Massive, white travertine with some lenticular vugs, from western quarry on the Limestone claims	<5	<.2	8	<2	4	<5	<5	<10	43	<5	<1	25
10	Random chip	12.0	Across massive, tan-to-white travertine outcrop	<5	<.2	7	<2	7	<5	<5	<10	32	<5	<1	35
11	Do..	15.0	Do..	<5	<.2	9	<2	7	<5	<5	<10	50	<5	<1	45
12	Do..	2.0	Across limestone and quartzite conglomerate	<5	<.2	10	2	26	<5	<5	<10	242	<5	1	35
13	Do..	2.0	Across limestone conglomerate	<5	<.2	10	<2	36	<5	<5	<10	43	<5	2	40

Appendix B.--Descriptions and whole-rock analyses of samples from the Garfield Mountain study area, Clark County, Idaho

[Al_2O_3, aluminum oxide; CaO, calcium oxide: Fe_2O_3, iron oxide; K_2O; potassium oxide; MgO, magnesium oxide; MnO, manganese oxide; P_2O_5, phosphate oxide; Na_2O, sodium oxide; SiO_2, silicon oxide; TiO_2, titanium oxide, LOI, loss on ignition; all concentrations in weight %; NA, not applicable]

Sample no. (fig. 2)	Sample type	Length (m)	Description	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_5	MnO	LOI
1	Random chip	10.0	Across tan, slightly iron-oxide-stained travertine outcrop	1.10	0.08	0.05	0.29	55.20	0.01	0.03	<0.01	<0.01	0.005	43.15
2	Do..	10.0	Do..	1.25	.05	.03	.26	56.05	.01	.05	.01	.15	.003	42.80
4	Grab	NA	Vuggy, tan travertine with 0.6-cm-thick laminae	2.25	.41	.13	.36	53.40	.03	.07	.01	<.01	.002	41.75
5	Do..	NA	White, crystalline travertine from Fritz Creek quarry	.86	.05	.01	.27	54.25	<.01	.02	<.01	<.01	.002	42.40
6	Do..	NA	Travertine with narrow vugs and laminae	1.85	.35	.09	.32	53.60	.02	.07	<.01	<.01	.005	41.80
7	Do..	NA	Do..	1.05	.10	.05	.27	54.80	.01	.04	.01	<.01	.007	43.25
8	Do..	NA	Massive, white travertine from eastern quarry on the Limestone claims	1.02	.07	.03	.35	55.10	.01	.04	.01	<.01	.002	42.90
9	Do..	NA	Massive, white travertine with some lenticular vugs, from western quarry on the Limestone claims	.85	.03	.02	.32	55.20	<.01	.02	<.01	.03	.003	43.10
10	Random chip	12.0	Across massive, tan-to-white travertine outcrop	1.03	.08	.03	.35	54.80	<.01	.03	<.01	.02	.002	42.85
11	Do..	15.0	Do..	1.00	.08	.03	.33	55.25	.01	.03	<.01	.01	.003	43.20